Systemic Design as Effective Methodology for the Transition to Circular Economy

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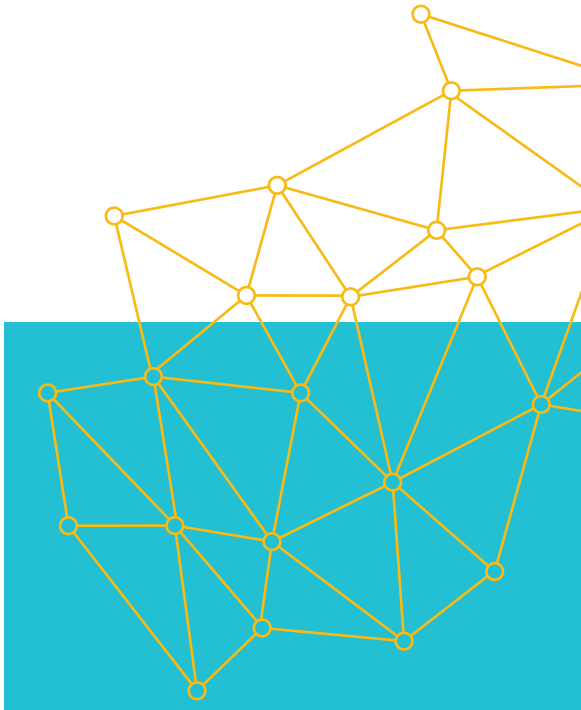

Systemic Design Method Guide for Policymaking:

A Circular Europe on the Way

volume 1

Edited by
Silvia Barbero

Allemandi

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Interreg Europe

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Development Fund

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List of abbreviations

ADEME French Environment and Energy Management Agency

ANR French National Research Agency

BIT National Strategy for Bioeconomy

C2C Cradle to Cradle

C2CN Cradle to Cradle Network

CE Circular Economy

DfD Design for Disassembly

DG Directorate-General

EAP Environment Action Programme

EC European Commission

EcoSD Eco-design of Sustainable Systems

ENEC European Network of Ecodesign Centers

EPA United States Environmental Protection Agency

ERDF European Regional Development Fund

ERT European Round Table of Industrialists

ESF European Social Fund

ETC European Territorial Cooperation

EU European Union

FP7 Seventh Framework Programme

FVs Field Visits

GDP Gross Domestic Product

GODC Slovenian Governament Office for Development and European Cohesion Policy

GPs Good Practices

GPP Green Public Procurement

HD Holistic Diagnosis

ISWA International Solid Waste Association

LP Lead Partner – Politecnico di Torino

LSR Large Scale Retail

JTS Joint Technical Secretariat

MA Managing Authority

MSc Master of Science

MSW Municipal Solid Waste

NGO Non-Governmental Organization

NISP National Industrial Symbiosis Programme

OECD Organisation for Economic Co-operation and Development

OPs Operational Programmes

POR-FESR Regional Operational Program - European Regional Development Fund

PP2 Second Partner – Piedmont Region

PP3 Third Partner – Azaro Foundation

PP4 Fourth Partner – Beaz Bizkaia

PP5 Fifth Partner – Higher School of Advanced Industrial Technology (ESTIA)

PP6 Sixth Partner – Association for Environment and Safety in Aquitaine (APESA)

PP7 Seventh Partner – Slovenian Government Office for Development and European Cohesion Policy

PP8 Eighth Partner – Romanian North-East Regional Development Agency (NERDA)

R&I Research and Innovation

RAPs Regional Action Plans

RES Renewable Energy Source

RIS Regional Innovation Strategies for Smart Specialization

ROP Regional Operational Programme

SD Systemic Design

SG Steering Group

SYDERE Systemic Design Research and Education

SME Small Medium Enterprise

SRIP Strategic Research and Innovation Partnerships

TAA Total Agricultural Area

TEPCV Positive Energy Territory For Green Growth Label

ToR Terms of Reference

UAA Useful Agricultural Area

UNFCCC United Nations Framework Convention on Climate Change

WCED World Commission on Environment and Development

WTO World Trade Organization

ZERI Zero Emissions Research and Initiatives

ZGZD Zero Waste Territories Label

Preface

Erwin Siweris

As Europe is moving towards an accelerated global economy, it is vital to adopt proper governance actions to achieve a sustainable future. In this context, it is necessary that new policies come from the effort and commitment of multidisciplinary teams. Interreg Europe helps regional and local governments across Europe to develop and deliver better policy. Supported by the European Regional Development Fund with 359 million euros from 2014 to 2020, the programme fosters regional policymakers through cooperation projects and policy learning platforms.

In 2016 we introduced the RETRACE Project (A Systemic Approach for Transition towards a Circular Economy)[1] which was financed under the first call for proposals of the Interreg Europe ETC Programme, 4.2 Specific Objective: Improving resource efficient economy policies. This project is a coordinated work between universities, local authorities, government offices, associations and public administration whose main aim is to address the EU challenge of transitioning towards a Circular Economy following the priorities set up by the "Flagship Initiative for a Resource-efficient Europe" for a shift towards a resource-efficient, low-carbon economy to achieve sustainable growth as enshrined in the Europe 2020 strategy and the EC Communication "Towards a Circular Economy: A Zero Waste Programme for Europe".

The outcome of the project over the first 16 months has been remarkable, facing stimulating challenges and achieving brilliant results by the eight partners of the project from Italy, Spain, France, Slovenia and Romania. Among the main achievements are:

6 field visits in the five partner regions and in The Netherlands;
48 good practices of Circular Economy and Systemic Design exchanged;
5 Holistic Diagnosis assessing the state of the art of the 5 partner regions in relation to Circular Economy related policies;
5 regional dissemination events, one in each country, with more than 250 attendees;
5 stakeholder groups formed in the partner regions, involving more than 70 entities;
4 videos showing the good practices encountered during the field visits;
2 newsletters sent to over 700 contacts.

This volume entitled *RETRACE Systemic Design for Policymaking: a Circular Economy on the Way* is addressed to regional policymakers and policy managers and is the first of a three book series that the RETRACE Project will deliver across a four-year period (2016–2020). Its main purpose is to illustrate to policymakers the Systemic Design as a tool to define sustainable activities based on Circular Economy.

The Systemic Design methodology and the results achieved in this first phase of the project constitute the main focus of the book which also offers a glimpse on what is expected in the next years with the definition of five Regional Action Plans focused on the development of Circular Economy policies in all partner regions. Eventually, the second phase of the project, from 2018 to 2020, will be devoted to the implementation of these policies.

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[1] www.interregeurope.eu/retrace

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2.4 Systemic Design as Effective Methodology for the Transition to Circular Economy

SILVIA BARBERO

The goal of this chapter is to clarify the connections between circular economy and the Systemic Design approach, which helps to define a methodology for reaching the common goal of local sustainable development that all policymakers aim to achieve.
Firstly, a parallel vision of circular economy characteristics and Systemic Design principles is presented in order to underline their common traits and understand their strong differences. This allows to define a methodology that can be pursued by local actors, including policymakers, for the transition towards a more sustainable and circular economy.
Lastly, special attention is given to the role of local actors in this transition and how the Systemic Design methodology can enhance territorial relationships towards circular economies.

2.4.1 THE RELATION BETWEEN SYSTEMIC DESIGN AND CIRCULAR ECONOMY PRINCIPLES

The aim of this essay is to investigate the relation between the characteristics of Circular Economy (CE) and the principles of Systemic Design (SD) in order to converge to the common goal of a sustainable development of our regions. The most important aspect is also the definition of a specific and valuable way to reach this goal. What are the steps that local actors can adopt to design a new sustainable scenario for their regions?

As broadly confirmed, the sustainable development requests the balance of the 3 Ps: people, planet and profit (Elkington, 1998) for inter-generational and intra-generational equity (WCED, 1987) through a holistic perspective (Hjorth and Bagheri, 2006). In recent years, the concept of CE seems to embody the sustainable development in our linear and inefficient economies (Murray et al., 2015). The five fundamental characteristics of CE (Ellen MacArthur Foundation, 2015) help the transition from a linear to a more sustainable economy not only at economy level, but also for its impact on the environment and society.

The objective of the circular economy is to replicate the quasi-cyclical of the natural ecosystems (Bourg et al., 2006). In this sense, industrial ecology and circular economy can be equal, as the industrial ecology discloses the urgent need for transition from productive linear systems to non-linear processes (Frosh & Gallopolous, 1989), even if we should be conscious that the non-linearity of productive systems is not necessary the same as their circularity.

The five main characteristics of CE[1] can help to understand the aspects of this new economy, as explicated in the Ellen MacArthur Foundation report "Towards a Circular Economy: Business Rationale for an Accelerated Transition" (2015):

WASTE IS DESIGNED OUT: waste does not exist when the biological and technical components or materials are designed by intention to fit within a biological or technical materials cycle. Biological materials are non-toxic and can easily be returned to the soil by composting or anaerobic digestion. Technical materials (polymers, alloys, and other man-made materials) are designed to be recovered, refreshed and upgraded, minimising the energy input required and maximising the retention of value (in terms of both economics and resources). Resource efficiency means keeping the added value through the prudent use of raw materials and energy throughout the value chain (Yuan et al., 2006), and using products as long as possible (Bilitewski, 2012).

DIVERSITY BUILDS STRENGTH: diverse systems with many connections and scales are more resilient in the face of external shocks than systems built simply for efficiency. Across many types of systems, diversity is a key driver of versatility and resilience. In living systems, for example, biodiversity is essential to surviving environmental changes. Similarly, economies need a balance of various scales of businesses to thrive in the long term. The larger enterprises bring volume and efficiency, while the smaller ones offer alternative models when crises occur (Goerner et al, 2009). Modularity, versatility, and adaptivity are prized features that need to be prioritised in a fast-evolving world.

RENEWABLE ENERGY SOURCES POWER THE ECONOMY: renewable energy decrease the resource dependence and increase the systems resilience (to oil shocks, for example). This will be further enabled by the reduced threshold energy levels required in a restorative CE. For example, the agricultural production system runs on current solar income but significant amounts of fossil fuels are used in fertilisers, farm machinery, processing and through the supply chain. More integrated food and farming systems would reduce the need for fossil-fuel based inputs and capture more of the energy value of by-products and manures.

THINK IN SYSTEMS: many real-world elements, such as businesses, people or plants, are part of complex systems where different parts are strongly linked to each other, leading to some surprising consequences. The ability to understand how parts influence one another within a whole, and the relationship of the whole to the parts, is crucial. Elements are considered in relation to their environmental and social contexts. While a machine is also a system, it is clearly narrowly bounded and assumed to be deterministic. Systems thinking usually refers to the overwhelming majority of real-world systems: these are non-linear, feedback-rich, and interdependent. In such systems, imprecise starting conditions combined with feedback lead to often surprising consequences, and to outcomes that are frequently not proportional to the input. Such systems cannot be managed in the conventional, 'linear' sense, requiring instead more flexibility and more frequent adaptation to changing circumstances.

PRICES REFLECTS REAL COSTS: prices can act as messages, so need to reflect full costs in order to be effective (Webster, 2015). The full costs of negative externalities should be revealed and taken into account, and perverse subsidies should be removed. A lack of transparency on externalities acts as a barrier to the transition to a CE.

This is according to an economical point of view. However, as a designer I would like to investigate which is the most effective methodology for the transition to a CE. Recent studies on the evolution of design for sustainability strategies show an evolution from a narrow technical, product- and process-centric focus towards large-scale system level changes (Adams et al., 2016). The methodologies involved in this evolution go from product level (i.e. cradle-to-cradle design, biomimicry design), to product-service system level (i.e. Product-Service System design), spatio-social level (i.e. Design for Social Innovation), socio-technical system innovation level (i.e. Design for System Innovations and Transitions) with an increasing potential toward beneficial sustainable effects (Ceschin and Gaziulusoy, 2016). I would add to this last level also the Systemic Design (SD) methodology developed at the beginning of this century at Politecnico di Torino and ZERI Foundation, thanks to the collaboration between design disciplines with Luigi Bistagnino's expertise and economical disciplines with Gunter Pauli's experiences. This methodology allows to design the flow of material and energy from one element of the system to another, transforming outputs of one process into input for another one (Bistagnino, 2011), potentially resulting in new, locally-based, value chains (Barbero, 2012).

The five principles of SD[2] can help to understand that the goal is to reach a more sustainable economy and society, like the CE, furthermore we can find a defined methodology to design new systems and reach it. As the Bistagnino's book *Systemic Design* (2011) extensively explains, the five SD principles are:

1. *Output becomes input*. The wastes of a system become the resources of another one, which generate a continuous flows of material, energy and information tending to zero emissions. This is the basic principle that helps anthropic processes to imitate nature.
2. *Relations generate the system*. The different elements of a system are connected with each other by the exchange of material, energy and information, generating the strengths of the system itself. The relationships developed within the generated system are open and inclusive.
3. *The system is self-generating*. The autopoietic open systems are self-supported and reproduced to evolve according to the changes occurring in the context. Like biological systems, the system is self-regulating and dynamically stable to change with the co-evolution of the system as a whole.
4. *Actions are local*. The operational context is prioritised by wisely using local resources. The cultural material heritage is preserved and any system can be replicated in another place. The scalability and replicability of systems is considered as an *unicum* (Barbero and Bicocca, 2017).
5. *The human being is at the centre of the project*. The relationship between man and context is the heart of the project, though not in an anthropocentric way. The human component should be considered in the design process in order to guarantee the respect of local culture and know-how.

I would like to underline the strong similarities between CE characteristics and the SD principles: first of the all, the principle related to the waste as a new matter to be seen in a more creative way is the base for both. We can state that this principle is the fundamental one to find the way towards a sustainable development.

We can also notice the common intention of the second characteristic of CE about the resilience of connections with the second and third principles of SD about the relations and the autopoiesis of the system. In both cases, relations among different elements of the systems can change dynamically according to the context in order to maintain the system alive. However, one aspect differs: in CE the generation of close loop is a must; in SD the relations generate open systems, more similar to a network than a circle. In the first case the closed loops refer to the biological nutrients and the recirculation of durable materials in the anthropic process means control the input of material to maximise recycling and recovery and to minimise the waste to landfill. In the second case the openness of the system derives from the Nature imitation, where the output od one Natural Reign is never metabolised by the same Reign, so the flow of material and energy from one Reign to another, and another one again, in order to guarantee the total elimination of waste.

The others characteristics and principles are less corresponding even if we can find some parallelism, for example the priority given by the CE on renewable energy is not explicit in SD principles even if the fourth principle of acting locally can lead to the same conclusion. To enforce this statement, I can quote some studies where the SD is applied to the energy sector and the outcome remains the same (Barbero and Pereno, 2013).

The CE characteristics enforce their attention to economy aspects also with the last principle related to the definition of prices. On the other side, the SD principles stress more the social aspects favouring the human factor, especially according to the last principle. We can say that they are two sides of the same coin. The two approaches of SD and CE are complementary and functional to the goals of the RETRACE Project, i.e. supporting the transition of regions and regional policies towards CE.

2.4.2 The Systemic Design Methodology towards a Circular Economy

In the SD approach, besides the general principles and goals, we also have a clear methodology that can be followed, as a designer of new systems, in order to pursue theories and principles. The knowledge process is always explored through theory and practice, analysis and synthesis, and takes into account the methodological and practical approaches deriving from the current debate on CE (Nigrei, 2016).

The SD methodology consists of five main steps, applied also in the RETRACE Project, which follows an iterative path and where any additional move is checked and reviewed based on the feedback received:

1. *Quality and quantity analysis (Holistic Diagnosis)*[3] Desk and field research are combined together to investigate the current situation of the context in which the project will be created. This is the most important phase in order to ensure the solidity and effectiveness of the project that can only originate from a careful analysis of the backdrop. The main effort is concentrated in gathering all useful information concerning the economic, social and environmental aspects to obtain a thorough analysis. Once the data have been collected with many different tools, the connections and influences between them are analysed to properly assess the issues that

need to be tackled. Holistic Diagnosis, truly enables to identify the unexpressed potentialities of a territory looking at it from a different perspective that does not only consider the economic aspect of profitability, but takes also into account the material culture, the local history, the traditional know-how, the local resources and the features of the environment to understand which connections can be created between processes in order to ensure a sustainable long-term development.

2. *Best practices selection in different context*[4] Next to the definition of Holistic Diagnosis, a research on the best practices addressed by the project is performed. This activity aims to identify good practices from which it is possible to learn and transfer relevant elements.
3. *Identification of problems*[5] From the framework outlined in the Holistic Diagnosis it is possible to identify the main issues that need to be addressed and the connections among them. Problems are regarded as leverages for change from which the project can be defined and initiated.
4. *Creation of solutions*[6] This step refers to the real design phase, i.e when a solution to the identified problem is provided. The solution originates from the knowledge acquired through the previous steps by applying a design thinking approach. The suggested solution undergoes a process of verification and validation before being implemented to foresee possible outcomes. The connections generated in this new system can offer new possibilities (for example: enhancement of outputs, savings on waste management, creation of new products from waste) for the actors involved, creating value at a local level.
5. *Implementation*[7] After the solution has been validated through preliminary studies and simulations, the project can be implemented. A continuous cycle of feedbacks from step 5 to step 1 allows to modify the project according to changes occurring in the framework.

In the last fifteen years this methodology has been tested and validated thanks to many different projects with different applications all around the world. Through these experiences the methodology has become stronger and increasingly successful. Many projects that applied the SD methodology were Italian and involved in the agro-food sector, such as the EN.FA.SI. project co-funded by Regione Piemonte under the POR-FESR 2007-2013 programme and developed with local enterprises (Agroinnova, Arese Franco, Molino Borgo San Dalmazzo). The aim of the EN.FA.SI project is the valorisation of all the wastes related to the farming and the food processing of a local type of bean (Fagiolo Cuneo) (Fiore & Tamborrini, 2014). The metal-mechanical sector was also tested with the multinational company NN Europe, that designs and manufactures high-precision metal and plastic components and assemblies for a variety of markets on a global basis. The project's goal is to avoid chemicals in the cleaning process of ball bearing production in order to have a wasted liquid that can be easily metabolised by the Natural Reign (Campagnaro, 2009). In the construction sector some projects are done in strict relation with the agro-food sector. It is important to underline that one project cannot be bounded to only one productive category because the intention is to merge and connect as many productive systems as possible. Other important application tests are done with territorial development projects in many different regions of the world, like for example in Mexico, in the Ahuacuotzingo region with the Red Mexicana de Mujeres, Cavideco, and Sudemur. The project's goal is to appraise local resources (material and human ones) to help developing the entire village and region (Barbero and Bicocca, 2015). Eventually, application to immaterial project like for example the definition of policy

roadmaps, prove one more time the effectiveness of the SD methodology for designing new ways towards local sustainable development.

As a matter of fact, the convergence of intents between SD and CE principles and characteristics towards a sustainable scenario clearly helps establishing the priorities in local development. As described in this paragraph, the SD methodology contributes to defining these goals. CE requires a scientific methodology in order to guarantee valuable results and a holistic vision over this complex system.

2.4.3 Systemic Design Enhances Territorial Relationships Generated through CE

The SD methodology should be developed and applied by multidisciplinary teams of local actors, since the information requested is a lot and the field of intervention is very broad. Furthermore, it is crucial to have local actors involved from the beginning of the entire process of development in order for the project to achieve success. In this context, the designer assumes the role of "designer mediator", whose "aim is to build or consolidate the team and the mediated integration between different types of knowledge and different specialism" (Celaschi et al., 2013). The systemic designers should design the throughputs that transform the output in input in a continuous metabolization within the complex system, mainly in step 4 (creation of solutions); moreover, they should manage the hard dialogue from the different actors in all the methodological steps. The basic ecosystem is the local community with its active participation mainly in the implementation phase (step 5). In order to be successful, for the project it is crucial to involve the local community from the early stages to achieve a successful implementation phase and obtain long term results.

The dialogue among different actors is difficult not due to the differences in languages but based on cultural barriers. Hence, systemic designers have the responsibility to build a trustful environment to foster relations among all the involved actors. In order to build up trust, I would like to mention another crucial player: the "connective actor" (Bicocca, 2016), who can be a single person or an organization that is already active and well-known and therefore knows the people who need to be involved and how to establish a dialogue among all actors.

The design of new local systems towards CE is a genuine dialogue among actors, in which feedbacks are mostly welcomed and can change many times during the different phases of the evolution process (Lee et al., 2005).

Eventually, the SD methodology fosters and encourages collaboration among a large number of local actors not only in terms of matter and energy exchange, but also in terms of knowledge and sharing expectations.

[1] For further details on Circular Economy, chapter 1.2 by Emanuele Bompan gives a comprehensive overview on this topic.

[2] For further details on SD, chapter 2.3 by Luigi Bistagnino gives a comprehensive overview on this topic.

[3] For further explanations on how the Holistic Diagnosis is applied in the RETRACE Project, see paragraph 4.1.1. by Carolina Giraldo Nohra and Chiara Battistoni who give a detailed description of the data collected by all partners and stakeholders.

[4] Specification on how the best practices are selected in the RETRACE Project and shared among partners and stakeholders is described in paragraph 4.1.2. by Agnese Pallaro.

[5] Policy gaps in the RETRACE Project correspond to this methodological step and are described in the Holistic Diagnosis Report.

[6] In the RETRACE Project this step corresponds to the definition of the Five Regional Action Plans (RAPs) and their corresponding Policy Briefs. A detailed description of this step applied to the RETRACE Project can be found in paragraph 4.1.3 by Ander Muñoz Urbizu.

[7] Implementation is a key element of the RETRACE Project, which has dedicated half of the duration of the project (two years) to it. The second phase of the project starts 1st April, 2018 and will end 31st March, 2020 when all the actions mentioned in the RAPs will be verified.

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Glossary

Bioeconomy, Biobased Economy

The part of economy that refers to the conversion of renewable biological resources into products through new efficient biotechnologies is called Bioeconomy. Intensive scientific and research activities have allowed the development of economic activities focused on the creation of vital products such as food and feed, but also bio-based products and bioenergy, starting from the products of land and sea (e.g. crops, forests, fish, animals and micro-organisms).
The term was first mentioned by Juan Enriquez and Rodrigo Martinez (Life Sciences Chief Strategist at IDEO) at the Genomics Seminar in the 1997 AAAS meeting and afterwards an excerpt of the paper was published in *Science Magazine*.
Bioeconomy was considered as a point of interest by Europe and on 13 February 2012 the Europe's Bioeconomy Strategy was launched and adopted under the lead of DG Research and Innovation and co-signed by several other Commission departments (Agriculture and Rural Development, Environment, Maritime Affairs, and Industry and Entrepreneurship). The strategy would like to answer to environmental global challenges such as increasing populations, depletion of natural resources and climate change and the white paper on "Bioeconomy" sets vision 2030 along with policy recommendations.

See: *http://biotechsupportbase.com/2014/02/06/bio-economy/*
See: *https://ec.europa.eu/research/bioeconomy/index.cfm*

Blue Economy

In the European context the Blue Economy can refer to two different conceptions. One is the economy derived from the blue growth, the long term strategy for the marine and maritime sectors by the European Union. The other is the open-source movement lead by Gunter Pauli, a Belgian businessman and former Ecover CEO, who is the action part of ZERI (Zero Emissions research and initiatives). In this publication we refer to the second notion.
Born as a report to the Club of Rome, the book *Blue Economy* by Gunter Pauli firstly presented in November 2009 describes "100 innovations that can create 100 million jobs within the next 10 years." The author demonstrates, taking inspiration from nature, that it is possible to create innovative business models which coexist in harmony according to nature's evolutionary path. The manifesto declares that local systems of production and consumption are able to generate multiple products and services and build social capital based on their own resources.

See: *http://www.theblueeconomy.org/*
See: *http://www.zeri.org/ZERI/About_ZERI.html*
See: *https://ec.europa.eu/maritimeaffairs/policy/blue_growth_en*
See: *https://www.ellenmacarthurfoundation.org/circular-economy/schools-of-thought/blue-economy*

By-Product

Defined in the Cambridge Dictionary as "something that is produced as a result of making something else," in the context of production it is the "output from a joint production process that is minor in quantity and/or Net Realizable Value when compared with the main products" (Wouters, 2012: 535). Its Net Realizable Value usually is not inventoried but "is recognized as 'other income' or as a reduction of joint production processing costs when the by-product is produced" (WTO, 2004).

In December 2005, the European Commission defined the distinction between waste and by-products as part of the Thematic Strategy on the prevention and recycling of waste: "by-product is a production residue that is not a waste" (European Commission, 2007).

See: *http://dictionary.cambridge.org/it/dizionario/inglese/by-product*
See: *http://ec.europa.eu/environment/waste/framework/by_products.htm*
See: *https://en.wikipedia.org/wiki/By-product*
European Commission (2007). Communication from the Commission to the Council and the European Parliament on the Interpretative Communication on Waste and By-Products. Available http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007DC0059 (Accessed 18th May 2017)
World Trade Organization (2004). United States. Final Dumping Determination on Softwood Lumber from Canada, WT/DS264/AB/R.
Wouters, M., Selto, F.H.; Hilton, R.W.; Maher, M.W. (2012). *Cost Management: Strategies for Business Decisions*. New York City, New York, US: McGraw-Hill.

Cascade Effect

As defined by the Oxford Dictionary, a cascade effect is defined as "a process whereby something, typically information or knowledge, is successively passed on and a succession of devices or stages in a process, each of which triggers or initiates the next." The term is applied to many different contexts, mainly medicine and ecology.

See: *https://en.oxforddictionaries.com/definition/us/cascade*
See: *http://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/cascade-effect*

Circular Economy

According to the definition provided by the Ellen MacArthur Foundation, Circular Economy is "restorative and regenerative by design. In a circular economy, there are two kinds of material cycles: biological, capable of being reintegrated into the biosphere, and technical, destined to be re-valorized without entering the biosphere. As envisioned by the originators, a circular economy is a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. It works effectively at every scale." In a Circular Economy, the use of resources (input) is optimised and the production of by-products or waste (output) is minimised through different kinds of actions that include design for long lasting products, maintenance, reuse, recycling, repair, remanufacturing and refurbishing. This approach is opposed to the linear economy, guided by the "take, make, dispose" production model.

See: *http://www.c2cproducts.com/detail.aspx?linkid=1&sublink=6*
See: *https://www.ellenmacarthurfoundation.org/circular-economy*
See: *https://en.wikipedia.org/wiki/Circular_economy*

Clean Technology

Clean Technology is a broad term which refers to processes, products and services that, compared to traditional technologies, are characterized by: a lower environmental impact, superior performances and a more responsible and productive use of resources.

European Commission - Business Innovation Observatory (2014). *Clean Technologies. Closed-loop waste management*. Available http://ec.europa.eu/DocsRoom/documents/13396/attachments/2/translations/en/renditions/native (Accessed 18th May 2017)

Cradle to Cradle

The term (also cradle-to-cradle, C2C and cradle-2-cradle) is an evolution of the notion "cradle-to-grave".

Moving from the concept of a linear model for products that consider them from the resources extraction (cradle) to the disposal moment (grave), C2C implies concepts of sustainability, recover, reuse, considering the products from their birth to their re-birth. It started from a design context (cradle-to-cradle design) developing from the biological metabolism a model of "technical metabolism flow of industrial materials." It states that: "product components can be designed for continuous recovery and reutilization as biological and technical nutrients." "The cradle-to-cradle framework moves beyond the traditional goal of reducing the negative impacts of commerce (eco-efficiency), to a new paradigm of increasing its positive impacts (eco-effectiveness)."
The manifesto of this concept is dated 2002: *Cradle-to-Cradle: Remaking the Way We Make Things* by William McDonough and Michael Braungart. Today the terms Cradle to Cradle® and C2C® are registered trademarks of MBDC - McDonough Braungart Design Chemistry, LLC.

McDonough, W., and Braungart, M. (2002). *Cradle to cradle: Remaking the Way We Make Things*. New York City, New York, US: North Point Press.

See: *https://en.wikipedia.org/wiki/Cradle-to-cradle_design*

See: *https://en.wikipedia.org/wiki/Cradle_to_Cradle:_Remaking_the_Way_We_Make_Things*

See: *http://www.c2cproducts.com*

Design by Components

Methodology that focuses on the design of complex products such as large and small household appliances, electrical and electronic equipment, communication tools, work tools...) since the redefinition of its essential internal components. The proposals thus developed, in addition to optimizing the assembly of components, giving rise to innovative expressiveness over the usual image of these products. This methodology allow to give a longer life to the products, facilitating the maintenance and the use of the product.

Bistagnino, L. (2008). *The Outside Shell Seen from the Inside*. Milano, Italy: CEA.

Design for Disassembly

Design for Disassembly (DfD) is a design strategy that aims to reduce the environmental impacts of products, by considering — already in the design phase — the needs to disassemble a product (either for maintenance or for end-of-life treatment) as well as simplifying the dismantling operations and the separation of components and materials.

See: *http://www.core77.com/posts/15799/afterlife-an-essential-guide-to-design-for-disassembly-by-alex-diener-15799*

Ecodesign

Ecodesign is a broad term, defined by the European Union, as the "integration of environmental aspects into product design with the aim of improving the environmental performance of the product throughout its whole life cycle." Focused on reducing the environmental impacts of products, Ecodesign involves different design strategies, such as Design for Disassembly, Design by Components, Systemic Design, Design for Recycling, Design for Environment.

European Union (2009). Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. Available http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0125&from=EN (Accessed 18th May 2017)

Green Economy

Green Economy is an economy aimed at taking into account the environmental impacts of economic activities, minimising them. According to UNEP a green economy is low carbon, socially inclusive and resource efficient. As a result, human well-being is improved and environmental risks are reduced.

UNEP. (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers. Available www.unep.org/greeneconomy (Accessed 18th May 2017)

Happy Degrowth

Latouche, defines degrowth as "a political slogan with theoretical implications", whose function is to open up conceptual and practical opportunities for escaping the impasse and mentality of the current economy. This requires avoiding the trap of getting tangled in economic proposals and an economic idiom when envisioning the transition to a degrowth society, i.e. avoiding the "economism" that characterizes industrial society and which is at the heart of the ideology of development (Latouche, 2010).

Latouche, S. (2010). Regrowth (editorial). *Journal of Cleaner Production*, no. 18, 519–522.

Latouche, S. (2010). La Gauche, peut-elle sortir de l'économisme?, *La Décroissance*, no. 70, 5.

Industrial Ecology

Industrial Ecology is the study of material and energy flows through industrial systems. Focusing on connections between operators within the 'industrial ecosystem', this approach aims at creating closed-loop processes in which waste serves as an input, thus eliminating the notion of an undesirable by-product. Industrial ecology adopts a systemic point of view, designing production processes in accordance with local ecological constraints whilst looking at their global impact from the outset, and attempting to shape them so they perform as close to living systems as possible.

See: *https://www.ellenmacarthurfoundation.org/circular-economy/schools-of-thought/industrial-ecology*

Frosh, R.A., Gallopoulos, N.E. (1989). Strategies for Manufacturing. *Scientific American*, vol. 3, no. 189, 94-102.

Industrial Symbiosis

Industrial Symbiosis represents one of the subsets of Industrial Ecology. Industrial Symbiosis traditionally separates entities in a collective approach to competitive advantage involving physical exchanges of materials, energy, water and by-products (Chertow, 2000). Different industries collaborate among them for mutual economic and environmental benefit, even if partners should be independent ("across the fence"). Someone's waste is one's raw material, in a way that is economically and environmentally profitable. The Industrial Symbiosis is the development of industries in a system to reach improved performance. This is because exchanges enabled through collaborative synergistic connections have the potential to improve resource use efficiencies, thus contributing to the reduction of resource throughput and pollutant generation.

Chertow, M.R. (2000). Industrial Symbiosis: Literature and Taxonomy. *Annual Review of Energy and Environment*, vol. 25, 313-337.

Policy Design

Policies are revealed through texts, practices, and symbols, and discourse that define and deliver values including goods and services as well as regulations, income, status, and other positively or negatively valued attributes. Policy design refers to the content and substance of public policy; blueprints, architecture, discourses, and aesthetics of policy in both is instrumental and symbolic forms.

As an area of study Policy Design engendered a large literature in the 1980s and 1990s with prominent figures in the US, Canada, Europe and Australia. After the early 1990s, however, this literature tailed off and although some writings on policy design have continued to flourish in specific fields such as economics, energy and environmental studies, in the fields of public administration and public policy more generally the idea of 'design' was often replaced by the study of institutional forms and decentralized governance arrangements.

Schneider, A.L., and Ingram, H. (1997). *Policy Design for Democracy*. Kansas City, Missouri, US: University of Kansas Press.

See: *http://archives.ippapublicpolicy.org/Policy~Design~Principles~and*

Policy Instrument

A policy instrument is a means for public intervention. It refers to any policy, strategy, or law developed by public authorities and applied on the ground in order to improve a specific territorial situation. In most cases, financial resources are associated with a policy instrument. However, an instrument can also sometimes refer to a legislative framework with no specific funding.

Interreg Europe (2016). Interreg Europe Programme Manual. Available https://www.interregeurope.eu/fileadmin/user_upload/documents/Call_related_documents/Interreg_Europe_Programme_manual.pdf (Accessed 18th May 2017)

Recycle

As defined by the United States Environmental Protection Agency (EPA), "recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products."
It is a good alternative to "conventional" waste disposal that can valorise material and help lower greenhouse gas emission, in terms of CO_2. The act of recycling prevent the large number of waste of potentially useful materials and reduce the consumption of new raw materials. This is reflected in the reduction of energy usage, air pollution (mainly from incineration), and water pollution (mainly from landfilling).

See: *https://en.wikipedia.org/wiki/Recycling*

See: *https://www.epa.gov/recycle/recycling-basics*

Repair

According to the definition provided by the article of *Product Design in a Circular Economy*, "repair is the correction of specific faults in an obsolete product or in a product that is not working such as at first, bringing the product back to working condition, whereby any warranty on the repaired product generally is less than those of newly manufactured equivalents any may not cover the whole product, but only the component that has been replaced" (Hollander, 2017).

Den Hollander, M.C., Bakker, C.A. and Hultink, E.J. (2017), Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms. *Journal of Industrial Ecology*, vol. 21, 517–25. doi:10.1111/jiec.12610

Reuse

Reuse is the act or practice of using something a second time. This action helps saving time, money, energy and resources, activating the reprocessing of previously used items. The purpose of reuse can be duple: to maintain the original function of the object (conventional reuse) or to accomplish a different one (creative reuse or repurposing). It is totally different from recycling, which is the despondency of used items to make raw materials for the production of new products.

See: *https://en.wikipedia.org/wiki/Reuse*

Service Design

The asset of planning and organizing people, infrastructure, communication and material components of a service, in order to refine its quality and the interaction between the service provider and its customers is called Service Design.

This category of design may function as a way to provide changes to an existing service or to create a new service entirely. Service design uses methods and tools derived from different disciplines ranging from ethnography to information and management science to interaction design. The purpose of this methodology is to promote best practices for designing services in accordance with both the needs of customers and the competencies and capabilities of service providers. It can be Product-Oriented, Result-Oriented or Use-Oriented.

See: *https://en.wikipedia.org/wiki/Service_design*

Vezzoli, C., Kohtala, C., and Srinivasan A. (2014). *Product-Service System Design for Sustainability*. Oxford, UK: Greenleaf Publishing Limited.

Systemic Design

Systemic Design is a recent initiative in design that integrates systems thinking and human-centered design, with the intention of helping designers cope with complex design projects. The recent challenges to design coming from the increased complexity caused by globalization, migration, sustainability render traditional design methods insufficient. Designers need better ways to design responsibly and to avoid unintended side-effects. Systemic Design intends to develop methodologies and approaches that help to integrate systems thinking with design towards sustainability at environmental, social and economic level. It is a pluralistic initiative where many different approaches are encouraged to thrive and where dialogue and organic development of new practices is central.
In this publication we refer to the methodology defined by Professor Luigi Bistagnino, which is built around the key principle that the material and energy output of a system (waste) can become input for another one (resource), taking inspiration from nature (Bistagnino, 2011). These relationships generate an autopoietic system of interconnected processes where waste is reduced and that tends to produce zero emissions. This system is strictly connected to the local territory in which the process operates and is built around the needs of the people related to it.

See: *https://en.wikipedia.org/wiki/Systemic_design*

Bistagnino, L. (2011). *Systemic Design. Designing the productive and environmental sustainability*. Bra: Slow Food Editore.

Upcycle

Upcycling is the process of transforming by-products, waste and useless materials, and unwanted products into new materials or products characterized by better quality or better environmental value. This process is also known as "creative reuse". Upcycling is the opposite of downcycling, that transforms materials and products into new ones of lesser quality.

See: *https://en.wikipedia.org/wiki/Upcycling*

Authors' Biographies

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Jocelyn Bailey is a designer with particular expertise in social design and policy. She is a senior consultant at service design agency Uscreates, where she works with a range of government and public sector clients on strategic design projects. She is also pursuing a PhD through the Arts & Humanities Research Council's 'Design Star' Doctoral Training Programme. Based at the University of Brighton, her research examines and critiques the growing trend of design being used as a strategic and policy tool by governments, to support the development of practice in this field. In 2014 she was a Visiting Scholar at the V&A, working on a project for the AHRC, mapping social design research and practice. Previously, Jocelyn led the manufacturing, design and innovation team at Westminster think tank Policy Connect. She trained as an architect at Cambridge University, and has an MA in History of Art from Birkbeck College (University of London).

CYRIL BALDACCHINO
Engineer Cyril Baldacchino is an eco-innovation project manager at APESA, where he manages the team and eco-design projects. He holds a master degree in Information System Management, a diploma of IAE Pau / Engineering School of ESTIA and a master degree in Business Management from University of Bordeaux/Engineering School ESTIA. He has been working in the field of innovation and eco-design since 2004 while supervising various eco-design projects in different sectors (e.g. furniture, sport, biomass) with companies and several R&D projects, as the PREBIOM project concerning comparative life cycle assessment of different biomass valorisation routes within the Aquitaine region.

SILVIA BARBERO
Silvia Barbero, PhD is an Assistant Professor at Politecnico di Torino (Department of Architecture and Design). She is lecturer of Product Environmental Requirements at the Design and Visual Communication degree and of Systemic Design at the Systemic Design Master degree at Politecnico di Torino. She is also responsible for the stage & job design curriculum and member of the H2020@polito Committee in Advanced Manufacturing and Processing. Her research mainly focuses on Systemic Design applied to agro-food and energy systems. She is scientific coordinator of the RETRACE Project (Interreg Europe – I Call) on the development of local and regional policies moving towards a circular economy, preventing waste being released into the environment. She has been coordinator also of regional project, and team leader of international project.
She is the author of some books on sustainable design, furthermore she wrote more than 100 papers in peer-reviewed journals, book chapters and reviewed international conference proceedings.

CHIARA BATTISTONI
Chiara Battistoni is a systemic designer currently pursuing a PhD in Management Production and Design at Politecnico di Torino, working with the Systemic Design Research Group in the Department of Architecture and Design. Since her bachelor degree in Industrial Design and a Master in Ecodesign, she has been actively interested in Sustainable Environmental Design. Her research focuses on the territorial potentialities reached thanks to the Systemic Design Approach which she started investigating since her master thesis and through collaborative projects as a research fellow.

LUIGI BISTAGNINO

Architect and designer, he lives and works in Torino, Italy. Founder of the research group on Systemic Design at the Politecnico di Torino aimed at developing products and processes in order to obtain zero emission. He was full Professor of Industrial Design and president of Industrial Design Courses at Politecnico di Torino, now he founded the Systemic Approach Foundation. He has contributed with numerous essays and articles to many important national and international reviews.

He designed objects currently in production and won national and international design prizes such as "Il Compasso d'Oro ADI".

Coordinator and member of many national and European researches. Among his main publications: *Systemic Design* (2011); *The Outside Shell Seen from the Inside* (2008); *Design Piemonte* (2007); *Design with a Future* (2003).

EMANUELE BOMPAN

Emanuele Bompan is a journalist and communicator with an international experience and author of numeruos reports on energy, climate change, environment, US politics. He published the book *Che cosa è l'economia circolare* (2016), about the rise of circular economy.

He was awarded the Middlebury Environmental Journalism Fellowship and, four times, The Innovation in Development Reporting Grant. In 2015 he was awarded 1st prize of "Reporter per la Terra". In 2016 he received the DNI Google Award with the newspaper *La Stampa*. He has interviewed prime ministers, industry leaders, environmental gurus, intellectuals, all around the world. He has contributed to the following newspapers and magazines: *Reuters, El Paìs, Die Welt, Al Jazeera, Materia Rinnovabile, Vanity Fair, Donna Moderna, La Stampa, Sole24Ore, Left, Capital, BioEcogeo, Terra, l'Unità, il Fatto Quotidiano, Max, CityFactor, Equilibri.*

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Mr. Calleja is Director General for DG Environment, European Commission and former Director General of DG Internal Market, Industry, Entrepreneurship and SMEs (February 2012 to August 2015).

Prior to that, he worked in the cabinets of several Commissioners, including the President of the European Commission, advising on Transport and Competition matters, State Aids and the application of Community Law. Between 1999 and 2004 he was Head of Cabinet for both Commissioner Oreja and Vice-president Mrs. Loyola de Palacio, in charge of Transport and Energy. Daniel Calleja started his career in the Commission as Member of the Legal Service.

TIZIANA DELL'OLMO

Tiziana Dell'Olmo is working for the regional government of Piemonte since 2001. As regional coordinator of Interreg Programmes she developed a broad expertise in regional and European programming and development policies. In her current position within the University, Research and Innovation Unit, she supports the implementation of regional innovation policies and the strengthening of regional innovation system at national, European and international level.

MARJANA DERMELJ

Marjana Dermelj works in the Government Office for Development and European Cohesion Policy, Development Policies Division, at Slovenian Ministry, where she covers environmental issues. Prior to her work as a civil servant, Marjana worked in the non governmental sector (Umanotera, The Slovenian Foundation for Sustainable Development), where she ran several campaigns and eventually managed the fair trade shop 3MUHE. She holds a bachelor degree in Chemistry and successfully accomplished two post-graduate studies related to environmental policy and management.

Carolina Giraldo Nohra
Research Fellow on the RETRACE Project at the Politecnico di Torino, her work focuses on the Systemic Design methodology and the circular economy research, coordinating the Exchange of Experience activities across all partners. Prior to that, she worked on Systemic Design research in Latin American context at A Good Foundation in Amsterdam and also in the field of urban sustainability in South Africa with Future Cape Town, a leading African organisation. Since her Master in Ecodesign at Politecnico di Torino, she has been actively interested in sustainable development.

Jean-Michel Larrasquet
Emeritus Professor in Business Sciences, he has contributed numerous articles and books on change and innovation applying the approaches of Soft Systemics (Checkland), the Network Theory (Latour) and the Complexity Theory (Morin). He currently applies these theoretical approaches to operational contexts, dealing with responsible entrepreneurship and responsible territorial development. He is also Responsible for a think tank working on societal questions in the Basque Country.

Iban Lizarralde
Iban Lizarralde is specialized in systemic and engineering design and works on the management of innovation through different approaches. Familiar with eco-innovation and creativity tools, he also researches in the field of new sustainable business models and conviviality approaches. He is the project manager of RETRACE for the French partner ESTIA.

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Industrial Management and Information Technologies Engineer, he is currently working in Beaz (Economic and Territorial Development in the region of Bizkaia) as project manager, supporting entrepreneurs, startups and companies through their innovation and growth processes. Previously, he worked in various consulting positions, especially in banking, insurance and public sectors.

Agnese Pallaro
PhD candidate from the Department of Management and Production Engineering at Politecnico di Torino, her research focuses on environmental sustainability and Systemic Design. Since her Master in Ecodesign at Politecnico di Torino, she has been actively interested in Systemic Design. She is the communication manager of the RETRACE Project (Interreg Europe – I Call) for the Lead Partner on the development of regional policies to move towards a circular economy, preventing waste being released into the environment.

Pier Paolo Peruccio
Pier Paolo Peruccio is Associate Professor at Politecnico di Torino, Deputy Dean of the Design Courses, and Representative for International Affairs. He holds a PhD degree in History of Architecture and Urbanism and is lecturer of "History of Visual Communication and Design" at the Design and Visual Communication bachelor's degree, and of "Theory and History of Systemic Design" at the Systemic Design master degree at Politecnico di Torino. He is coordinator of the research "Innovation in Design Education: The Establishment of Innovation in terms of Content and Pedagogical Methods, Design Courses at the École Catholique d'Arts et Métiers de Lyon (Ecam)" that aims at activating in France a degree programme in collaboration with ECAM.
His research is mainly on the history of environmental sustainability related to the field of design. He carried out many research projects in public and private archives, such as the Rockefeller Archive Center at Tarrytown (USA), the MIT at Cambridge (USA) and the Archivio Storico Olivetti in Ivrea.

ESTIBALIZ PLAZA ELORDI

Estibaliz Plaza Elordi holds a degree in Business Administration and Management from the Deusto University. She is currently the Head of the Entrepreneurship Area of Azaro Fundazioa, where she has been working for more than 12 years. Her job is to advise entrepreneurs and companies in the definition and acceleration of business and innovation projects in order to maintain and generate employment in the Region of Lea-Artibai.

MARION REAL

With a strong background in user-centered design, ergonomics & human factor, Marion Real recently conducted a PhD in the field of eco-innovation. She takes part actively in the RETRACE Project applying the Systemic Design methodology in the Nouvelle Aquitaine region. Additionally, she has a strong interest in the recovery of clothing and the design of supply-chains built around natural fibers, recycled clothes and local products. In this same area of competence, she is developing an action research on cosmopolitan fashion localism for fashion.

RAMONA TANASĂ

Member of the External Cooperation Office in Nord-East Regional Development Agency in Romania, Ramona Tanasă begun her activity in the North-East RDA as Communication Officer for the North-East EUROPE DIRECT Centre, gaining expertise in desk research on European policies, programmes and initiatives and laying the base for identifying cooperation opportunities, information management and European policies and mainstream topics knowledge and awareness. Previously, she was working in banks, in entrepreneurial and economic education and knowledge, as well as in marketing and sales sectors.

PAOLO TAMBORRINI

Paolo Tamborrini is Associate Professor and Dean of the Design Courses at Politecnico di Torino. His research focuses on sustainable innovation and interaction design. He contributes to the following newspapers and magazines: *Il Giornale dell'Architettura*, *Domus* and *Il Sole 24 Ore* and is Managing Editor of the online publication *Graphicus*. He has published more than 100 scientific articles, proceedings and is the author of *Design Sostenibile, oggetti, sistemi e comportamenti* (2009).

BENJAMIN TYL

Dr. Benjamin Tyl is an eco-innovation research engineer. In 2011, he obtained a PhD degree for his work on eco-innovation, and more specifically on the contribution of creativity in the eco-ideation processes. Benjamin is an active member of the French EcoSD (Eco-design of Sustainable Systems) network, and member of the Design Society. He is currently working at the technological center APESA, where his role is to support the research activity and to develop research projects with both private companies and public laboratories. His main research interests are eco-innovation and eco-ideation but also the local value creation approach in design. Benjamin Tyl was coordinator of two research projects in eco-innovation with both academics and industrials (PSA, Steelcase, Parkeon, etc.), funded by the French National Network in Eco-design (EcoSD). He is currently the scientific leader of a research project on eco-innovation, funded by the French National Research Agency (ANR). Moreover, Benjamin is co-founder of a citizen company (I-ENER) that aims to develop a sustainable and territorial energy project.

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This volume aims at clarifying the role of Circular Economy according to a sustainable development and how policymakers can target it effectively in their activities. It is a guide to Systemic Design as a key methodology to establish sustainable regional action plans towards a Circular Economy.
As the result of an intense dialogue between people who present different perspectives and seek for a common language in the current complexity of policymaking and designing, this is the first of a three book series published across a four-year period (2016–2020) as part of the RETRACE Project funded by the Interreg Europe Programme.

Preface by Erwin Siweris

With contributions by
Jocelyn Bailey / Cyril Baldacchino / Silvia Barbero / Chiara Battistoni / Luigi Bistagnino / Emanuele Bompan / Daniel Calleja Crespo / Tiziana Dell'Olmo / Marjana Dermelj / Carolina Giraldo Nohra / Jean-Michel Larrasquet / Iban Lizarralde / Ander Muñoz Urbizu / Agnese Pallaro / Pier Paolo Peruccio / Estibaliz Plaza Elordi / Marion Real / Ramona Tanasă / Paolo Tamborrini / Benjamin Tyl

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